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ABSTRACT

Test score data for kindergarten and first grade children were subjected to several forms of multivariate analysis. First, all fall and spring kindergarten data were factor analyzed to reduce the test scores to the least number of dimensions possible. General ability factors corresponding to the expected test dimensions were obtained in all instances. In addition, there was clear evidence that the spring scores for the Standard English Repetition Test measured a separate dimension, but in the fall was not independent of general ability factors. Efforts to determine the best kindergarten predictors of first grade achievement indicated that general ability factors had the greatest predictive utility; knowing the alphabet and successful figure copying best predicted reading vocabulary achievement at the end of first grade. Effective reading prediction was obtained by tests of abstraction and ability to detect missing elements of a picture; in addition, these measures were the best predictors of arithmetic achievement. Fluency in Standard English was frequently present as a minor predictor; its relationship to reading achievement remains to be convincingly demonstrated. It is suggested that the abstraction and ability predictors, which are conceptual candidates for causative links with reading acquisition, be examined for possible program implications. (Author/CTM)

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THE KAMEHAMEHA EARLY EDUCATION PROGRAM

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Technical Report #54

The Prediction and Explanation of Academic Achievement

Ronald Gallimore Roland G. Tharp

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The Kamehameha Early Education Program

The Kamehameha Early Education Program (KEEP) is a research and development program of The Kamehameha Schools/Bernice P. Bishop Estate. The mission of KEEP is the development, demonstration, and dissemination of methods for improving the education of Hawaiian and Part-Hawaiian children. These activities are conducted at the Ka Na'i Pono Research and Demonstration School, and in public classrooms in cooperation with the State Department of Education. KEEP projects and activities involve many aspects of the educational process, including teacher training, curriculum development, and child motivation, language, and cognition. More detailed descriptions of KEEP's history and operations are presented in Technical Reports #1-4.

Abstract

KEEP data from the years 1972 to 1974 were subjected to several forms of multivariate analysis. First, all Fall and Spring Kindergarten data were factor analyzed to reduce the test scores to the least number of dimensions possible. The results indicated that general ability factors corresponding to the expected test dimensions were obtained in all instances. In addition, there was clear evidence that in Spring standard English fluency was a separate dimension, but in the Fall was not independent of general ability factors.

Efforts to determine the best kindergarten predictors of first grade achievement indicated that general ability factors had the greatest predictive utility. Knowing the alphabet and successful figure copying were the kindergarten tasks that best predicted reading vocabulary achievement at the end of first grade. Also, effective reading prediction was obtained by tests of abstraction and ability to detect missing elements of a picture; in addition, these measures were the best predictors of arithemetic achievement. Standard English fluency was frequently present as a minor predictor; its relationship to reading achievement remains to be convincingly demonstrated.

It is suggested that the abstraction and ability predictors, which are conceptual candidates for causative links with reading acquisition, be examined for possible program implications.

Technical Report #54

The Prediction and Explanation of Academic Achievement*

Ronald Gallimore Roland G. Tharp

To make sense of the data pool collected as part of the KEEP research program, a series of multivariate analyses were conducted. The first set of procedures--described as factor analysis--serve to reduce the number of dimensions to what can be considered least common denominators. The result is a limited number of factors that are made up of a larger number of variables. For example, it is common to find that many independent tests reduce to a single verbal ability factory. Knowing what tests measure the same basic dimensions, makes interpretation less complex and ambiguous.

The second series of analyses seek to identify what variables predict reading achievement. In this case we are interested in what tests given in kindergarten will predict reading achievement at the end of the first grade. Knowing what variables are predictive may assist program planning by specifying areas that require special attention in the case of children who have initial difficulty in reading.

The two analyses divide again into intra- and interdomain analyses. Intradomain analysis consisted of analyses of the subtests of the various measures routinely used at KEEP, for example the Wechsler Preschool and Primary Scale of Intelligence (WPPSI), the Metropolitan Readiness Test (Metro), the Standard English Repetition Test (SERT), and the Hawaiian Creole English Repetition Test (HCERT). Further description of these tests are available

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*We thank Dr. Kazuo Nihara, UCLA, for comments on the manuscript.

in various KEEP Technical Reports, (e.g. Gallimore et. al., Technical Report #5; Fox Technical Report #40; Day et. al., Technical Report #5; and Day et. al., Technical Report #28).

A minimum of interpretation is presented in this report. The major and obvious findings of the analyses are noted and the principal findings presented in table form. This preliminary report is an initial step toward comprehensive interpretation of four years of KEEP test results.

Factor Analyses

The factor analytic procedure followed a standard procedure in all cases. The UCLA BMD P series of programs was used. The principal method of factor rotation used was varimax; direct oblimin (an oblique) method was used in selected instances. However, no oblique structures were obtained, and these analyses are not presented. Factor extraction was accomplished by means of the maximum likelihood method; the number of iterations for initial factor extraction was set at four. The communality of a variable was estimated from its squared multiple correlation (covariance) with the factors. Factor rotation was limited to those with eigenvalues greater than 1.000. Kaiser's normalization procedure was used. Additional details on the computational features of the program used may be obtained from the UCLA BMD manual.

Fall Kindergarten Interdomain Factor Analysis

Data for 81 KEEP students were available, including WPPSI, Metro, SERT, and HCERT scores for Classes I, II, and III (Grades 2, 1, and K in 1974-75). Only Fall kindergarten scores were used, with exception of the HCERT which was first administered to all children in Fall, 1974.[1] Otherwise the scores used

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[1]The HCERT distribution of scores is skewed toward the upper end of the scale, thus minimizing the effects of age that characterize the SERT findings. Because assessing the role of Hawaiian Creole English is an important goal, the HCERT was included in these analyses since the age factor was minimized.

were those obtained when each child was at the same age and grade.

Table 1

Factor Analysis of Fall Kindergarten Tests, SERT, & HCERT

(N=81)

Variable	Communality*	Factor I
WPPSI Verbal IQ	.8309	.912
WPPSI Performance IQ	.6313	.795
SERT	.5702	.755
METRO	.3920	.626
HCERT	.1377	.371
	VP	2.562

*The communality of a variable is its squared multiple correlation (covariance) with the factors. This estimation procedure was used for all analyses presented here.

Table 1 presents the factor analysis of the principal KEEP test scores. Only one factor with eigenvalue greater than 1.0 emerged. Thus when KEEP children enter at kindergarten there is a single dimension--measured by these tests--that differentiates among individuals. It appears to be a general ability factor defined by WPPSI Verbal IQ (VIQ), Performance IQ (PIQ), SERT, Metro, and, to some extent, the HCERT.

In Table 2 we present an analysis of the tests, readministered after the children had completed their kindergarten year at KEEP. For convenience, the data are presented as rotated, sorted factor loadings. The factor loading matrices have been rearranged so that the columns appear in decreasing order of variance explained by the factors. The rows have been rearranged so that for each successive factor, loadings greater than .50 appear first; loadings less than 0.25 have been replaced by zero. All subsequent factor solutions are similarly presented. After nine months of school, two dimensions separate

Table 2

Factor Analysis of Spring Kindergarten Tests:
Varimax Solution

N=83

Variable	Communality	Factor I	Factor II
WPPSI Perf. IQ	.6313	.877	0.0
Metro	.3920	.803	.391
WPPSI Verbal IQ	.8309	.697	0.0
SERT	.5702	0.0	.996
HCERT	.1377	.403	.467
	VP	2.071	1.396

the children. The first factor defined by IQ and school readiness tests is clearly the expected general ability factor. Factor II is defined by the two language tests: the SERT and HCERT. The two factors are not entirely independent, since the Metro and the HCERT load on both factors. However, the separation of the two dimensions is satisfactory.

There are several plausible alternative explanations of Factor II. It may simply reflect the fact that both of the principal defining variables--SERT and HCERT--are repetition tasks. The factor might also describe a measure of general verbal fluency, independent of dialect.

In any event, over the course of the kindergarten year the initial test score homogeneity gives way to slightly greater diversity.

Intradomain Analysis: Fall and Spring WPPSI

The WPPSI total score is composed of 11 subtests, each of which measures a slightly different aspect of verbal or performance intelligence. These subtests, and the SERT and HCERT were subjected to the identical factor analytic procedure employed in the interdomain analysis.

Table 3 presents the results of the analysis, for the varimax rotation

method. Three factors emerge. The first and second are the familiar and predictable verbal and performance ability dimensions, virtually identical to Verbal IQ and Performance IQ scores. The third factor is principally defined by HCERT, with minor contributions by the WPPSI Information and Sentences subscales, and the SERT.

Table 3

Factor Analysis of Fall Kindergarten WPPSI Subtests, SERT, & HCERT: Varimax Solution

Variable	Communality	Factor I	Factor II	Factor III
Similarities	.7454	.811	.282	0.0
Comprehension	.7310	.780	.313	0.0
Information	.7697	.747	.370	.272
Vocabulary	.5826	.639	.404	0.0
Animal House	.6186	.609	.490	0.0
SERT	.5578	.562	.399	.288
Geometric Des.	.7775	0.0	.867	0.0
Arithmetic	.6354	.485	.611	0.0
Block Design	.5123	.332	.597	0.0
Mazes	.3332	0.0	.556	0.0
Picture Comp.	.3839	.357	.506	0.0
HCERT	.8069	0.0	0.0	.875
Sentences	.2281	.387	0.0	.280
	VP	3.612	2.940	1.131

Again verbal and performance factors emerge, with a third factor defined solely by the HCERT. The single most important and significant finding to emerge from this analysis of the Fall kindergarten WPPSI subtests, is the

loading of the SERT on the verbal ability factor. This strongly suggests that a major component or meaning of the SERT is verbal or language ability. Whether it represents an important additional piece of information about KEEP students remains to be seen.

Table 4 presents the factor analysis of WPPSI subtests data from the Spring kindergarten administrations. Again three factors emerge. The reliable verbal and performance factors are first and second respectively, and are more sharply defined in the Spring compared with the Fall. Indeed the

Table 4

Factor Analysis of Spring Kindergarten WPPSI Subtests, SERT, & HCERT: Varimax Rotation

Variable	Communality	Factor I	Factor II	Factor III
Vocabulary	.6922	.792	0.0	0.0
Information	.6683	.781	0.0	0.0
Similarities	.6159	.741	0.0	0.0
Comprehension	.6342	.716	.347	0.0
Arithmetic	.5896	.631	.423	0.0
Geometric Design	.6808	.284	.775	0.0
Mazes	.4547	0.0	.667	0.0
Animal House	.4847	.335	.579	0.0
Block Design	.4736	.373	.557	0.0
Picture Completion	.4287	.387	.515	0.0
Sentences	.9165	0.0	0.0	.957
SERT	.8759	0.0	0.0	.924
HCERT	.4214	.268	.332	.489
	VP	3.279	2.498	2.160

separation of factors provided by varimax solution was deemed sufficient. However, SERT is no longer loaded on Factor I, loading instead on Factor III.

Factor III in Table 4 is both interesting and resolves the question raised by the loadings of the HCERT and SERT in Table 3. It appears that by the Spring of the kindergarten year the children can be separated in terms of how well they perform on a repetition task: SERT, HCERT, and WPPSI Sentences (another repetition task).

Factor III may be a language fluency dimension. After one year of kindergarten the childrer are differentiated by facility in language, as well as general verbal ability (Factor I). Table 4 also provides the first evidence that whatever is measured by the SERT may not be completely identical with verbal ability or IQ.

Intradomain Analysis: Fall and Spring Metro Subtests

Table 5 presents the factor analytic results for the Metro subtests collected from kindergarteners in the Fall. Factor I apepars to be a general school readiness factor (including SERT), as might be expected from the rationale of the Metro. Factor II is a puzzle. Two of the defining variables (listening and word meaning) suggest it may be a language or communication dimension; however the addition of the alphabet subtest suggests it may be a preschool-no preschool factor. That is, about half of KEEP children attended preschool, and what they learned may differentiate them at kindergarten entry.

Table 5

Factor Analysis of Fall Kindergarten Metro Subtests, SERT, & HCERT: Varimax Solution

Variable	Communality	Factor I	Factor II
Numbers	.7605	.750	.445
Matching	.5846	.723	0.0
Alphabet	.6491	.635	.496
SERT	.4278	.613	0.0
Copying	.4584	.528	.424
Listening	.5958	.519	.572
Word Meaning	.9948	0.0	.983
HCERT	.1174	.339	0.0
	VP	2.555	2.034

Table 6 presents the results for the factor analysis of the Spring Metro subtests. Compared to the solutions obtained for the Fall scores, the Spring results are somewhat more interpretable. Factor I appears as a school readiness factor; Factor II seems best described as a language factor, defined by SERT, HCERT, and word meaning, though two other subscales are also loaded.

As in the case of the WPPSI subtests (Tables 3 and 4), the SERT shifts from a general ability to a more specific language factor over the course of the kindergarten year. The fact that this shift occurs in the factor structure of both the WPPSI and Metro suggests that a dimension, measured by the SERT, emerges during the nine month interval between test administrations. As in the case of the WPPSI, the accompanying loadings suggest that in the Spring, a language fluency factor differentiates individual children.

Table 6

Factor Analysis of Spring Kindergarten Metro Subtests, SERT, & HCERT: Varimax Solution

Variable	Communality		Factor I	Factor II
Alphabet	.6834		.805	0.0
Numbers	.6149		.756	0.0
Matching	.5186		.618	.370
Listening	.2945		.525	0.0
Copying	.4463		.503	.440
SERT	.9070		0.0	.944
Word Meaning	.1870		.351	.253
HCERT	.3526		.345	.483
		VP	2.388	1.616

In Table 7 are presented the results of a factor analysis including the Gates-McGinitie Reading Achievement Tests. The Metro tests are not included since they conceptually and empirically overlap the reading test. Four factors emerge: the familiar Verbal and Performance factors and a fourth factor defined by the sentence repetition tasks. The third factor is defined by the reading tests. Thus reading represents a dimension separate from the ability factors. This supports our efforts to treat reading achievement as a conceptually meaningful independent variable in the subsequent presentation of multiple regression analyses. Additional factor analyses, (not represented) for example, Metro Subtest, WPPSI and Metro total scores, yield a solution in which the reading tests define an independent dimension.

Table 7

Factor Analysis of Spring Kindergarten WPPSI Subtests, SERT, HCERT, & Gates Reading Tests: Varimax Rotation

Variable	Communalities	Factor I	Factor II	Factor III	Factor IV
Vocab.	.6632	.822	0.0	0.0	0.0
Compre.	.7173	.813	0.0	0.0	0.0
Inform.	.6718	.797	0.0	0.0	0.0
Similar.	.6301	.721	0.0	0.0	0.0
SERT	.8074	.640	0.0	0.0	0.0
Arith.	.6050	.538	.257	0.0	0.0
Geo. Des.	.5962	0.0	.805	0.0	0.0
Mazes	.4655	0.0	.734	0.0	0.0
Animal Hse.	.4807	0.0	.536	0.0	0.0
Gates Vocab.	1.000	.285	0.0	.854	0.0
Gates Comp.	.4049	0.0	0.0	.647	0.0
Sentences	.6656	0.0	0.0	0.0	.815
HCERT	.5486	0.0	.252	0.0	.605
Block Des.	.5229	0.0	.495	.304	0.0
Pict. Comp.	.4721	0.0	.407	0.0	0.0
	VP	3.666	2.457	1.737	1.491

Summary: Factor Analytic Studies

The principal contribution of these analyses is clarification of the relationship between the SERT and the major KEEP testing efforts. In general, it appears that over the course of the kindergarten year SERT performance becomes increasingly differentiated. In the Fall, it is essentially indistinguishable from verbal ability and intelligence measures, and general school readiness; in the Spring it appears that the SERT becomes the major defining

variable of a language ability or fluency dimension. Ir the section that follows we will examine how well the SERT and the other variables predict first grade reading achievement. It is clear that what meaning is attached to the discovered relationships must take account of the change in meaning of the SERT from Fall to Spring durig kindergarten.

The somewhat strange behavior of HCERT throughout these analyses may be attributable to the skewness of its score distribution. This skewed distribution creates unstable correlation coefficients. In subsequent analyses, HCERT scores should be normalized in some way.*

The Prediction of First Grade Reading

The first step in the analysis is examination of the product moment correlations between the kindergarten test variables and first grade reading achievement. In this case reading achievement is assessed by means of the Gates-McGinitie Reading Test (see Technical Report 26 for additional information). Table 8 presents these correlations grouped in terms of the factor analysis results presented in Tables 1 and 2. Table 8 presents these correlations grouped in terms of the factor analysis results presented in Tables 1 and 2. Thus, for example, Fall kindergarten test scores are described in Table 8 as Factor I: Spring scores are labelled Factor I and II respectively. Because KEEP has had only two first grade groups at this writing, the number of cases involved in these correlational analyses is reduced to 53 (Classes I and II, or grades 2 and 1 in 1974-75).

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*Our appreciation is due Dr. Kazuo Nihara for this observation.

Table 8

Product Moment Correlations of Kindergarten Test Scores and First Grade Reading Achievement

Fall Kindergarten	Gates Reading Total	Vocabulary	Comprehension
Factor I			
WPPSI Verbal IQ	.44(.001)*	.43(.002)	.14(ns)
WPPSI Perform IQ	.54(.0001)	.55(.0001)	.23(.10)
SERT	.46(.001)	.58(.0001)	.26(.07)
Metro	.62(.0001)	.61(.0001)	.40(.006)
HCERT	.00(ns)	.08(ns)	.00(ns)
Spring Kindergarten			
Factor I (Ability)			
WPPSI Perform IQ	.44(.002)	.47(.001)	.16(ns)
Metro	.56(.001)	.62(.0001)	.28(.05)
WPPSI Verbal IQ	.50(.0006)	.57(.0001)	.22(ns)
Factor II (Language Fluency)			
SERT	.46(.001)	.57(.0001)	.20(ns)
HCERT	.23(.10)	.24(.07)	.07(ns)

*Significance levels are presented in parentheses.

Correlations with first grade reading are significant for all Fall kindergarten test variables, except for HCERT (first administered in Fall 1974).

More importantly, the Spring kindergarten data suggest that both Factor I and Factor II are significant predictors of first grade reading. This is important because it was on the Spring data that the SERT emerged as part of a dimension separate from the general ability or readiness factor in Tables 1 and 2. Thus this is evidence that the SERT--whatever it measures--is a probable component of successful reading acquisition. At the same time, it is important to emphasize the highly significant relationships between the variables that comprise Factor I and the reading scores.

The significantly greater correlations between the various tests and Gates Vocabulary compared to the Comprehension (the two subtests of the Gates test) is a pattern that will be noted throughout this section. At present,

KEEP has no good predictor of performance on the Comprehension portion of the reading test. Partly, this is due to the attentuated, or restricted distribution of scores we have obtained to date. Thus, for the remainder of this analysis, the focus will be on the Vocabulary section, or in simpler terms, the measure of a child's reading vocabulary; this measure assesses both sight and decoding, as reflected by the number of words a child can read.

Stepwise Multiple Regression Analysis

The next analysis applied to the KEEP data was stepwise regression analysis. This technique determines the best predictor(s) of selected dependent variables. In this case, we sought to determine what test scores obtained in the Fall and Spring of the KEEP kindergarten were the best predictors of reading achievement at the end of first grade. The computer program used "tries out" all possible combinations of variables and yields a series of best variable models.

The best two variable model is obtained by first obtaining the best one variable model producing the highest $\underline{R}^2$, (square of the multiple correlation coefficient). Then another variable, the one which would yield the greatest increase in $\underline{R}^2$, is added. Once this two-variable model is obtained, each of the variables in the model is compared to each not in the model. For each comparison, the program determines if removing the variable in the model and replacing it with the presently excluded variable would increase R^2. After all possible comparisons, the program selects the "best" two variable model. This process is repeated for three, four, and so on, variable models.

Cautious interpretation of these data is essential. Because of missing cases and availability of first grade reading scores for only two KEEP classes, the analysis was performed on 44 cases. Conservative views on the number needed for multiple regression analysis usually recommend around a minimum of 100 cases--otherwise inflated values are likely. Since we are looking for

some means of separating on a relative basis the value of our various predictive tests, and because we will use these results for heuristic purposes only, there is sufficient rationalization for use of the procedure.

Also, stepwise regression is used to determine predictive utility, not conceptual or theoretical relationships. The best predictor may be a test that is empirically identical to the criterion. A conceptually important variable may be a poor predictor relative to an empirically identical but conceptually trivial test. Test X given in Fall may better predict Text X re-administered in Spring. But a lower correlation of Test Y in Fall with Test X in Spring may be more significant because Y is hypothesized to be a determinant of X. The correlation of X with itself may be of predictive utility, but is conceptually trivial. One way to check for causal relationships with correlational data is use of the cross-lagged panel design, a procedure we will employ when our sample sizes increase.

In Tables 9 and 10 are presented the stepwise regression analyses of Fall and Spring kindergarten test scores, predicting to the Gates Vocabulary score obtained at the end of first grade.

The best Fall kindergarten predictor of reading vocabulary achievement is the SERT ($\underline{R}$=.607). Adding WPPSI Performance IQ to SERT increases $\underline{R}$ to .683, accounting for an additional ten percent of the Vocabulary variance. The addition of WPPSI Verbal IQ, HCERT, and Metro add distinguishable but relatively minor predictive utility. Since these are Fall data, the SERT predictor must be interpreted in terms of the general ability factor on which it is loaded (see Table 1). Eliminating the Metro from the analysis changes the magnitude of $\underline{R}$ only slightly.

Predicting from Spring kindergarten scores, another combination of tests proves to be the best predictors. In this case, it is the Metro first (.595);

Table 9

Stepwise Regression Analysis of Fall Kindergarten Tests and Gates Vocabulary Scores

With Metro

No. of Variables	Variables	R	R^2
1	SERT	.607	.368
2	Perform. IQ & SERT	.683	.467
3	Verbal IQ (+ above 2)	.716	.512
4	HCERT (+ above 3)	.731	.534
5	Metro (+ above 4)	.742	.55

(No other variables met criterion for inclusion)

Without Metro

No. of Variables	Variables	R	R^2
1	WPPSI Perform. IQ	.62	.382
2	Perform. IQ & SERT	.65	.426
3	WPPSI Verbal IQ (+ above 2)	.68	.458
4	HCERT (+ above 3)	.69	.481

(No other variables met criterion for inclusion)

Table 10

Stepwise Regression Analysis of Spring Kindergarten Test Scores and Gates Vocabulary: With and Without Metro

With Metro

No. of Variables	Variables	R	R^2
1	Metro	.595	.354
2	Metro & WPPSI Verbal IQ	.623	.388

(No other variables met criterion for inclusion)

Without Metro

No. of Variables	Variables	R	R^2
1	WPPSI Verbal IQ	.561	.315
2	SERT & Verbal IQ	.59	.344
3	SERT & Verbal IQ & Perform IQ	.61	.369

(No other variables met criterion for inclusion)

and adding the WPPSI Verbal IQ raises R to .623. Together they account for 62 percent of the vocabulary variance. Again both variables are components of a general ability factor (see Table 2). Again, nearly as good prediction was obtained when the Metro was deleted from the analysis.

In terms of the factor analysis, Factor I in both Fall and Spring includes tests that provide adequate prediction of reading scores. This is especially important in view of the fact that SERT loads on Factor II of Spring kindergarten results--thus in terms of predictive utility, the SERT adds nothing to that obtained by the Metro and Verbal IQ. It should be noted that this finding does not detract from the conceptual significance of the significant product moment correlations reported in Table 8. It indicates which variables have greater predictive utility, not which have most conceptual meaning.

The Metro was the best predictor of Gates Comprehension scores, both in

Fall ($\underline{R}$=.405) and Spring ($\underline{R}$=.260).

Stepwise Regression Analysis: Fall and Spring Metro Subtests, SERT, and HCERT

Since the Metro is the Spring best predictor of reading achievement, we will examine first which of its subtests is most predictive.

The best Fall kindergarten predictor of Gates Vocabulary was the Alphabet subtest of the Metro ($\underline{R}$=.648); the second best predictor was Copying. These data are presented in Table 11.

Table 12 presents the data for Fall kindergarten prediction of the Gates Comprehension test. In this case, the two best predictors are the same as for Vocabulary, with the order reversed (Copying and Alphabet).

Table 13 presents the data for Spring kindergarten Metro subtests. Again, Alphabet is the best predictor of Vocabulary scores, with SERT the second best predictor. With the combination of Alphabet and SERT, just under 50 percent of the Vocabulary score variance is accounted for (The Spring kindergarten data accounted for a trivial amount of Comprehension score variance, and are not reported here.)

In sum, the Metro subtests and the SERT combine in various orders to predict extremely well the Vocabulary reading scores obtained from 12 to 18 months later. Alphabet measures a child's ability to recognize or pick out letters of the alphabet that are read to him; copying requires the child to duplicate a set of increasingly difficult figures. Presumably copying measures visual perception and motor control similar to what is required to learn handwriting. The emergence of the SERT as a predictor in the Spring kindergarten data is consistent with its loading on a language factor that separates from the Metro subtests, (see Table 6) and its independent correlation with reading score (see Table 8).

Table 11

Stepwise Regression Analysis of Fall Metro Subtests, SERT, HCERT, and Gates Vocabulary

No. of Variables	Variables	R	R^2
1	Alphabet	.648	.420
2	Copying (+ above)	.716	.513
3	Wordmeaning (+ above)	.729	.531
4	Wordmeaning, Alphabet, Numbers, & Copying	.738	.545
4	Matching, Alphabet, Numbers & Copying	.743	.552
5	Wordmeaning, Matching Alphabet Numbers, & Copying	.758	.574

(No other variables met criterion for inclusion)

Table 12

Stepwise Regression Analysis of Fall Metro Subtests, SERT, HCERT, and Gates Vocabulary

No. of Variables	Variables	I	R^2
1	Copying	.438	.192
2	Alphabet (+ above 1)	.481	.231
3	Listening (+ above 2)	.523	.274
3	Wordmeaning, Listening, & Copying	.545	.297
4	Wordmeaning, Listening, Alphabet, & Copying	.560	.314
5	Wordmeaning, Listening, Alphabet, Numbers, & Copying	.576	.332

(No other variables met criterion for inclusion)

Table 13

Stepwise Multiple Regression Analysis of Spring Kindergarten Metro Subtests, SERT, HCERT, and Gates Vocabulary

No. of Variables	Variables	R	R^2
1	Alphabet	.647	.418
2	SERT (+ above)	.693	.480
3	Wordmeaning (+ above 2)	.719	.517
4	Numbers (+ above 3)	.730	.533

(No other variables met criterion for inclusion)

Stepwise Regression Analysis: Spring Kindergarten WPPSI Subtests, SERT, & HCERT

In Table 14, the predictive utility of the Fall kindergarten test scores is presented for the Gates Vocabulary. SERT is the best predictor, but again it must be interpreted in terms of the general ability factor reported in Table 3 which presents the results of the factor analysis of WPPSI subtests and SERT. However, a remarkably good prediction of Vocabulary reading scores can be made in the Fall of the kindergarten year.

Table 15 presents the results for the Spring kindergarten WPPSI subtests. Of the first four predictors (combined R of .713, 50 percent of the variance accounted for), three are subscales of the Verbal portion of the WPPSI. The single exception is Picture Completion which forms part of the Performance subsection. The predictors, in order of importance, are Similarities, Picture Completion, Comprehension, and Information (combined R=.713).

Table 16 presents the Spring kindergarten analysis for Gates Comprehension scores. The magnitude of the correlations is low, but it is interesting that the Performance subtests and the SERT do combine to provide what little prediction was obtained.

Table 14

Stepwise Regression of Fall WPPSI Subtests, SERT, HCERT, and Gates Vocabulary

No. of Variables	Variables	R	R^2
1	SERT	.597	.357
2	Geometric Design and SERT	.683	.466
2	WPPSI Sentences, & Geo. Design	.688	.474
3	WPPSI Sentences (+ above)	.712	.507
3	WPPSI Sentences, Comprehension, & Geo. Design	.723	.521
4	Comprehension, SERT, Sentences, & Geo. Design	.763	.582
5	HCERT (+ above)	.787	.619
6	Block Design (+ above)	.799	.639
7	Mazes (+ above)	.807	.651

(No other variables met criterion for inclusion)

Table 15

Stepwise Regression Analysis of Spring WPPSI Subtests, SERT, HCERT, & Gates Vocabulary

No. of Variables	Variables	R	R^2
1	Similarities	.647	.419
2	Picture Comp. (+ above 1)	.675	.456
3	Comprehension (+ above 2)	.688	.474
4	Information (+ above 3)	.713	.508
5	Block Design (+ above 4)	.722	.521
6	SERT (+ above 5)	.731	.534
7	Sentences (+ above 6)	.746	.556

(No other variables met criterion for inclusion)

Table 16

Stepwise Regression Analysis of Fall WPPSI Subtests, SERT, HCERT, and Gates Comprehension

No. of Variables	Variables	R	R^2
1	Geometric Design	.261	.068
2	Geometric Design & SERT	.30	.093
2	SERT & HCERT	.326	.106
3	Block, SERT & HCFRT	.386	.149
4	Arith, Block, SERT, & HCERT	.419	.176
5	Geometric Design (+ above 4)	.451	.203

(No other variables met criterion for inclusion)

Metropolitan Arithmetic Test

In Spring, Classes I and II were given the Metropolitan Arithmetic Achievement Test. Best predictors of arithmetic achievement were determined in a fashion identical to the reading test analysis.

Tables 17, 18, and 19 present these data. In Table 17, the WPPSI, SERT, and HCERT are analyzed as independent variables; the dependent variable is the Metropolitan Arithmetic Test (Standard Scores). Two significant predictors were obtained: WPPSI Verbal and Performance IQ.

Of the WPPSI subtests, Similarities, Geometric Design, and SERT combine to account for slightly more than 60 per cent of the arithmetic test variance. Additional variance is accounted for by the addition of three more WPPSI subtests for a total of 68.9 per cent (see Table 18).

In Table 19, the SERT, HCERT, and Metro Readiness test scores were used to predict arithmetic scores. Surprisingly, the HCERT is the third best predictor though the amount of variance accounted for is minimal. Metro Matching and Numbers subtests are the best predictors.

Perhaps most significant about these results is the importance of verbal

measures in the prediction of arithmetic achievement. This adds to the conclusion of the reading test score analysis that most critical to KEEP child performance are those skills that implicate verbal and language abilities. Why the HCERT should emerge as a predictor is a mystery, since it has rarely been a factor of importance in our analyses. However, since the HCERT loads consistently on the same dimension as the SERT this finding may have little conceptual importance.

Table 17

Stepwise Regression Analysis of Spring Kindergarten WPPSI, SERT, HCERT, and Metropolitan Arithmetic

No. of Variables	Variables	R	R^2
1	WPPSI Verbal IQ	.71	.510
2	WPPSI Perf. IQ & Verbal	.74	.541

(No other variables met criterion for inclusion)

Table 18

Stepwise Regression Analysis of Spring Kindergarten WPPSI Subtests, SERT, HCERT, and Metropolitan Arithmetic

No. of Variables	Variables	R	R^2
1	Similarities	.68	.457
2	Geo. Design (+ above 1)	.76	.570
3	SERT (+ above 2)	.78	.613
4	Comprehension (+ above 3)	.80	.648
5	Information (+ above 4)	.82	.679
6	Mazes (+ above 5)	.83	.689

(No other variables met criterion for inclusion)

Table 19

Stepwise Regression Analysis of Spring Kindergarten Metro Subtests, SERT, HCERT, and Metropolitan Arithmetic

No. of Variables	Variables	R	R^2
1	Matching	.66	.435
2	Numbers (+ above 1)	.73	.539
3	HCERT (+ above 2)	.75	.570
4	Listening (+ above 3)	.77	.590

(No other variables met criterion for inclusion)

Discussion

As expected, general ability variables and school readiness skills are the most important dimensions represented in the KEEP data pool. That is the inevitable result of the test selection, but it makes sense as well. The single most important determinant of learning to read is possession of the requisite abilities and skills. The Spring administrations of the WPPSI and Metropolitan Readiness Test are about equally good predictors of first grade reading achievement.

At several junctures in these analyses, the SERT (Standard English Repetition Test) has emerged as a significant variable. First, it apparently shifts its meaning from the Fall to the Spring of the kindergarten year; in the Fall it is indistinguishable from the other general ability tests. In the Spring it changes, and loads on a language ability or fluency factor (see Tables 1 and 2). This shifting of loading from one factor to another is repeated in the factor analyses of the subtests of the WPPSI and the Metro.

In Table 8 we reported a significant correlation between Spring kindergarten SERT and first grade reading vocabulary. This is noteworthy because it is the Spring SERT that is factorially independent of general verbal ability.

However, in the series of stepwise regression analyses, the SERT emerges as a "best" predictor secondary to Spring kindergarten Metro subtests and the WPPSI Verbal IQ. Given a choice there are better predictors of first grade reading vocabulary; and if those are available then the SERT makes only a modest contribution to predictive utility. In terms of conceptual meaning, other measures may be more significant.

The Metro and its subtests emerge as predictors of Vocabulary reading achievement largely because of task similarity rather than conceptual significance. Knowing the alphabet and successful figure copying may duplicate what is measured by the Gates to such an extent that the value of this information rests solely on its predictive utility. Conceptual explanation is more appropriately sought from the WPPSI subtests and the SERT data. Table 15 suggested that Spring kindergarten SERT scores are relatively minor predictors of Reading vocabulary, compared to the WPPSI tests. Perhaps we should examine closely the cognitive requirements of Similarities and Picture Completion. Those requirements may be worth some direct instruction. At present Standard English fluency remains an unproven factor in reading acquisition. The abstract capacities demanded by the WPPSI subtests may be more significant determinants.